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**Maintainability Recommendations for Aircraft Wheel and Brake Design**

**1. SCOPE:**

This SAE Aerospace Recommended Practice (ARP) recommends the maintainability features which should be considered in the design of aircraft wheels and brakes. The effect on other factors, such as, cost, weight, reliability, and compatibility with other systems should be weighed before the incorporation of any of these maintainability features into the design.

**1.1 Purpose:**

The purpose of this ARP is to identify design features for aircraft wheels and brakes which would enhance their maintainability.

**2. REFERENCES:**

There are no referenced publications specified herein.

**3. RECOMMENDED DESIGN FEATURES:**

**3.1 Wheels:**

- 3.1.1** It is desirable that heat shields, if used, and not of the continuous type, should be readily removable without the removal of brake rotor drive keys so wheel inspection procedures are not prevented or hindered. Reasonable care should be exercised in the design of the shield to prevent destructive abrasion between the shield and basic wheel material. Heat shields should be designed to preclude damage, material breakout, excessive wear or looseness in attachment areas. The wheel heat shields should also be designed to minimize direct contamination of brake friction components by deicing and cleaning fluids. Heat shields should be processed to eliminate sharp edges and surfaces that could injure maintenance personnel. Heat shields should not protrude beyond the wheel contour (drive keys). It is desirable that heat shields be nonhygroscopic.

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- 3.1.2 Wheel bearing seal rubbing surfaces should be readily replaceable and have adequate abrasion resistance to prolong service life of the sealing surface. The design should provide for ease of replacement and/or repair of the rubbing surface(s).
  - 3.1.2.1 Grease seals should be provided on both sides of the inboard and outboard wheel bearings. Wheel grease dams which are an integral part of the forgings should be avoided.
- 3.1.3 The wheel and/or brake should be designed so that the wheel assembly rotor drive keys cannot be improperly aligned with the brake assembly rotors during wheel installation.
  - 3.1.3.1 If a device is mounted on the wheel to prevent improper alignment of the wheel with the brake rotors, the device should be readily replaceable, sturdy and positively fastened.
- 3.1.4 Possible fretting between wheel halves at mating surfaces, such as the inner and outer registers, and tie bolt boss areas, should be minimized by the use of adequate bearing area, tie bolts of sufficient number, size and preload, and judicious selection of spacer materials.
- 3.1.5 Consideration should be given to maintenance inspection procedures during the selection of wheel processes, finishes, and coatings used to protect the wheel from corrosion.
- 3.1.6 Inboard and outboard wheel halves should be clearly identified by part and serial number and be readable when the wheel is installed on the aircraft. Impression stamping, etching, or embossing should be located only in noncritical areas. Raised pads are preferred. Space should be provided to mark tire changes or inspection events. In addition, mounting provisions should be provided on both wheel halves for the attachment of bar code plates which are visible from the outside of the assembled wheel.
- 3.1.7 Reusable balance weight attachment provisions, for statically balancing the wheel half assemblies, should be considered.
- 3.1.8 Materials used for the impregnation of cast wheels should be resistant to paint stripping solutions and hydraulic fluids.
- 3.1.9 Aircraft quality wheel bearings of a standard size should be used when ever practical. When selecting aircraft wheel bearings, consideration should be given to designs that prevent installation of otherwise matching parts with different load ratings.
- 3.1.10 Sufficient material should be provided in the structure of the wheel to allow for the rework and installation of cup bushings or oversize bearing cups. Adequate material should provided in into the nose wheel rim to allow rework for the removal of possible tow bar damage. Adequate material should be allowed in the bead seat and tubewell area to compensate for some allowable corrosion and fretting damage.

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- 3.1.11 The tire inflation sealing areas (o-ring groove) of a tubeless wheel should be designed for protection from handling damage.
- 3.1.12 Aircraft standard hardware should be used wherever possible.
- 3.1.13 Thermal sensitive pressure release devices (fuse plugs), should be located so that they are accessible for removal when the tire is installed on the wheel assembly for commercial applications and require tire removal for military applications.
- 3.1.14 Provision should be made for removal of all parts from the basic wheel halves, such as inserts, bearing cups and bushings, to accommodate necessary overhaul operations without damage to the wheel areas around these parts.
- 3.1.15 As an anticorrosion measure, provision should be made for adequate drainage of the installed wheel so that fluids will not be trapped or held in pockets. Adequate material should be provided to permit rework of areas which commonly encounter corrosion. The design should include provisions to inhibit galvanic corrosion.
- 3.1.16 Adequate space should be provided around the bolt heads and nuts to accommodate standard socket wrenches without damaging the finish of adjacent structure due to contact. Adequate material should be provided to allow for corrosion and mechanical damage removal around bolt holes and hole faces and for the installation of bushings for suitable repair. An even number of tie bolts should be considered to allow interface with the most commonly used twin spindle torquing machines.
- 3.1.17 The wheel should be designed so that it can be maintained with commercially available tools, especially tire bead breakers.
- 3.1.18 The wheel should be designed to permit disassembly with relative ease for tire mounting.
- 3.1.19 Large bore inflation valves are desirable. The inflation valve should be located in an accessible location for tire servicing, and adequate clearance for valve extension should be provided to permit the use of standard air chucks. Location of the tubeless valve should be such as to permit valve removal without wheel disassembly. Space should be provided for possible installation of a tire pressure gage/fill valve assembly.
  - 3.1.19.1 Inflation valves, pressure gauges, etc (protruding items) should be mounted so they are recessed in the bowl of the wheel half and thus protected from damage during handling of the wheel.
- 3.1.20 Thread inserts should be provided in tapped holes, or adequate material provided to accommodate inserts for repair.
- 3.1.21 The wheel and its components should be designed to prevent the improper assembly of parts to the extent practical.

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### 3.1.22 Wheel Rotor Drives:

- 3.1.22.1 The wheel drive inserts (drive keys or drive caps) should be wear resistant and easy to remove. Blind holes should be avoided when attaching inserts to the wheel structure.
- 3.1.22.2 If torque bar drives are used, they should be attached to the wheel by standard fasteners on one end, and the other end should interface with the wheel in a hole that is drilled through and provides for a replaceable repair bushing. All drive designs should be wear resistant and suited for high temperatures.
- 3.1.23 Provisions should be considered for the installation of a tire pressure indicator. This indicator should be visible after wheel installation and should have sufficient accuracy to indicate whether the tire pressure is within safe operating limits.
- 3.1.24 The disassembly warning information presented on the wheel should be easily visible regardless of the orientation of the wheel.
- 3.1.25 Inboard and outboard wheel halves should consider machined surfaces which can provide for (automated) ultrasonic testing in critical areas.
- 3.1.26 Wheel hub cap attachment should allow for easy removal/installation during wheel/tire change. V-clamps are a preferred design.
- 3.1.27 The wheel, grease seals, and wheel bearings should be designed in such a way that the wheel bearings and grease seals will remain with the wheel assembly on installation and removal from the aircraft. This will prevent possible bearing and seal contamination.

### 3.2 Brakes:

- 3.2.1 All inlet and bleeder ports should be equipped with replaceable threaded bushings. In the case of the inlet, self-sealing hydraulic quick disconnect couplings are preferred.
- 3.2.2 The bleeder fittings and inlet ports should be readily accessible for servicing with the brake and wheel assembly installed on the aircraft.
- 3.2.3 Hydraulic interconnection passages in brake piston housings should be designed to provide for complete natural bleeding with the brakes installed on the aircraft in both the normal and jacked positions.
- 3.2.4 Actuation piston cavities should be fitted with replacement piston sleeves that have a wear resistant surface in contact with the piston seal. It is desirable that the seal be retained on the outside diameter of the piston and the sleeve.
  - 3.2.4.1 To the extent practical, the brake assembly should use standard static and dynamic seals and their installation should be simple and not require any special tools.